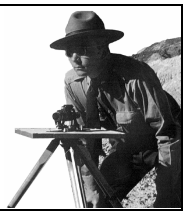
GEOLOGIC RESOURCE MONITORING PARAMETERS

Relative Sea Level



Brief Description: The position and height of sea relative to the land (relative sea level - RSL) determines the location of the shoreline [see shoreline position]. Though global fluctuations in sea level may result from the growth and melting of continental glaciers, and large-scale changes in the configuration of continental margins and ocean floors, there are many regional processes that result in rise or fall of RSL that affect one coastline and not another. These include: thermal expansion of ocean waters, changes in meltwater load, crustal rebound from glaciation, uplift or subsidence in coastal areas related to various tectonic processes (e.g. seismic disturbance and volcanic action), fluid withdrawal, and sediment deposition and compaction. RSL variations may also result from geodetic changes such as fluctuations in the angular velocity of the Earth or polar drift. Tide-gauge records suggest an average global sea-level rise over the past century of 0 to 3 mm per year, though there is no firm evidence of acceleration in these rates. Indeed, a recent study by the US Environmental Protection Agency predicts that global sea level is likely to rise 15 cm by 2050 (about 3 mm/year) as a result of human-induced climate warming.

Significance: Changes in RSL may alter the position and morphology of coastlines, causing coastal flooding, waterlogging of soils and a loss or gain of land. They may also create or destroy coastal wetlands and salt marshes, inundate coastal settlements, and induce salt-water intrusion into aquifers, leading to salinization of groundwater. Coastal ecosystems are bound to be affected, for example, by increased salt stress on plants. A changing RSL may also have profound effects on coastal structures and communities. Low-lying coastal and island states are particularly susceptible to sea level rise. It is estimated that 70% of the world's sandy beaches are affected by coastal erosion induced by RSL rise.

Environment where Applicable: Marine coastlines

Types of Monitoring Sites: Near harbors, shore installations and coastal communities. Holocene RSL trends can be investigated through geological studies of beach ridge plains, coastal terraces, coral reefs and other ‘bioconstructions’, beaches, marshes, the intertidal zone, and coastal archaeological sites.

Method of Measurement: Tide gauges, GPS techniques, and re-leveling surveys to identify changes in coastal land elevation. Holocene RSLs are commonly documented by locating a feature associated with a former sea level and determining its present elevation and age. In general, coastal lagoons, barrier coral reefs, and flooded river mouths imply submergence. More specific indicators include raised strandlines and marine shell deposits, drowned coastal deposits, and saltwater to freshwater transitions in silled basins.

Frequency of Measurement: Continuous for tide gauges, less frequent for other techniques such as re-levelling.

Limitations of Data and Monitoring: Though there are many ways to tell whether RSL has changed in a particular area, distinguishing land subsidence or uplift from submergence or recession due to other sources of sea-level change is difficult. For modern RSL, a datum is required, and because of high frequency variability, more than 30 years of data may be needed to establish a reliable trend. For Holocene RSLs, the lack of true sea-level indicators and the coarse temporal resolution make interpretation difficult. There are also errors introduced when dating geological and geomorphological features and when using them to determine the exact RSL position. Note that most of the RSL work has been carried out in the Northern Hemisphere (especially on both sides of the North Atlantic) and in the more developed countries: few RSL curves apply to Africa, Latin America, or Oceania or southern Asia.

Possible Thresholds: An important threshold is crossed when sea levels rise above the mean land elevation of coastal communities and terrestrial ecosystems or, at least, above a high-water level to which they have become adapted.

Key References:

Berger, A.R. & W.J.Iams (eds). Geoindicators: Assessing rapid environmental changes in earth systems. Rotterdam: A.A. Balkema. (see papers by Forbes & Liverman and Morton).
Emery, K.O. & D.G.Aubrey 1991. Sea-levels, land levels and tide gauges. New York: Springer-Verlag.

French, J.R., T.Spencer & D.J.Reed (eds) 1995. Geomorphic response to sea level rise: existing evidence and future impacts. Special issue of Earth Surface Processes and Landforms 20/1: 1-103.

Pirazzoli, P.A. 1991. World atlas of Holocene sea-level changes. Amsterdam: Elsevier.

Titus, J.G. & V.K.Narayanan 1995. The probability of sea level rise. US Environmental Protection Agency, Office of Policy, Planning and Evaluation.

Van de Plaasche, O. (ed) 1986. Sea level changes: a manual for the collection and evaluation of data. Norwich, UK: Geo-Books.

Warwick, R.A., E.M.Barrow & T.M.L.Wigley 1993. Climate and sea level change: observations, projections and implications. Cambridge: Cambridge University Press.

Related Environmental and Geological Issues: Many geomorphological changes in the marine coastal zone are affected by fluctuations in RSL. Low-lying islands and coastal cities are vulnerable to rising sea levels.

Overall Assessment: Understanding changes in coastal environments requires monitoring of relative sea levels.

Source: This summary of monitoring parameters has been adapted from the Geoindicator Checklist developed by the International Union of Geological Sciences through its Commission on Geological Sciences for Environmental Planning. Geoindicators include 27 earth system processes and phenomena that are liable to change in less than a century in magnitude, direction, or rate to an extent that may be significant for environmental sustainability and ecological health. Geoindicators were developed as tools to assist in integrated assessments of natural environments and ecosystems, as well as for state-of-the-environment reporting. Some general references useful for many geoindicators are listed here:

Berger, A.R. & W.J.Iams (eds.) 1996. Geoindicators: assessing rapid environmental change in earth systems. Rotterdam: Balkema. The scientific and policy background to geoindicators, including the first formal publication of the geoindicator checklist.

Goudie, A. 1990. Geomorphological techniques. Second Edition. London: Allen & Unwin. A comprehensive review of techniques that have been employed in studies of drainage basins, rivers, hillslopes, glaciers and other landforms.

Gregory, K.J. & D.E.Walling (eds) 1987. Human activity and environmental processes. New York: John Wiley. Precipitation; hydrological, coastal and ocean processes; lacustrine systems; slopes and weathering; river channels; permafrost; land subsidence; soil profiles, erosion and conservation; impacts on vegetation and animals; desertification.

Nuhfer, E.B., R.J.Proctor & P.H.Moser 1993. The citizens' guide to geologic hazards. American Institute for Professional Geologists (7828 Vance Drive, Ste 103, Arvada CO 80003, USA). A very useful summary of a wide range of natural hazards.